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SOME GENERIC SYNONYMY IN NORTH AMERICAN TORTOISE BEETLES WITH DESCRIPTIONS OF TWO NEW SPECIES[1]

MILTON W. SANDERSON,
Illinois Natural History Survey
and
EDWIN W. KING,
Department of Entomology.

A comparison of the hind wings of representatives of the tortoise beetle genera *Metriona* Weise (1896, p. 13), *Erepsocassis* Spaeth (1936, p. 260), *Strongylaspis* Spaeth (1936, p. 216) and *Coptocycla* Chevrolat (1837, p. 396), has indicated a very close similarity, and has suggested that most are perhaps not so distinct generically from one another as has been considered. With *Agroiconota* Spaeth (1913, p. 142) and *Jonthonota* Spaeth (1913, p. 141), they form a complex distinguished primarily from other adult cassidiid genera by the combination of a smooth anterior elytral margin, rounded anterior pronotal margin, and toothed or simple tarsal claws. However, this generic group is not clearly separated from other cassidiids by any combination of characters in the hind wings but the species considered here agree in having the medial recurrent projecting considerably basad of the *r-m* crossvein as shown in a typical cassidiid wing (fig. 1). All except *Jonthonota* lack strong peglike microtrichia along the hing margin. This characterization includes also the genera *Parorectis* and *Ctenochira* which by features other than the hind wings are eliminated from the present discussion.

Chaetotaxic characters in the hind wing, the longitudinal elytral stripes, and the basally shortened 6th row of elytral punctures will serve to separate *Agroiconota* from the other genera. Likewise *Jonthonota* and *Coptocycla* are readily distinguished from the remaining genera of the complex by the completely untoothed tarsal claws, but the wings do not indicate that these two genera together form a group isolated from some species of *Metriona.*

The remainder of these so-called genera, *Metriona, Erepsocassis* and *Strongylaspis*, have very similar hind wings, and the tarsal claws are toothed on at least one pair of legs in both sexes, but beyond this fact it is believed that the absence or presence of tarsal teeth or angulations is purely secondary in character and of value only in distinguishing the species. The male genitalia are extremely similar in spite of the tarsal differences among the males.

Strongylaspis was described to include only the genotype, *Coptocycla bisignata* Boheman (1855, III, p. 119), from North America. It was based primarily on the untoothed outer tarsal claw of the male. This feature applies only to the claws of the middle leg of *bisignata* and not to all claws of each pair as indicated by Spaeth. The females of *bisignata* and most *Metriona*

[1] This paper is a joint contribution from the Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey, and the Department of Entomology, University of Illinois.

species in North America have all claws toothed. The male of *Metriona purpurata Boheman* (1855, III, p. 300) has both of the middle claws untoothed, which species shows a close relationship to other members of *Metriona.*

The genus *Erepsocassis* was also erected to include the genotype *Coptocycla rubella* Boheman (1862, IV, p. 449). The origin of the species was unknown to Boheman, but the locality is questionably given by Blackwelder (1946, p. 750) as Brazil. He records the North American *Metriona marginepunctata Schaeffer* (1925, p. 236) as a synonym of *rubella.* The female of *Erepsocassis rubella* was characterized as having all tarsal claws toothed, but the male had both middle claws untoothed. *Metriona creola,* described in this paper, agrees with *rubella* in the characteristics of the tarsal claws and by having the last five antennal segments dark. However, the lateral margin of the elytron is described in *rubella* as punctured, but the margins are unpunctured in *creola.* A male and a female from Florida, identified as *marginepunctata,* differ from the description of *rubella* as follows: male with only one posterior claw toothed, female with one middle and one posterior claw toothed; both anterior claws of both sexes toothed. These two specimens further disagree with *rubella* by having the last four instead of five antennal segments darker than the preceding ones.

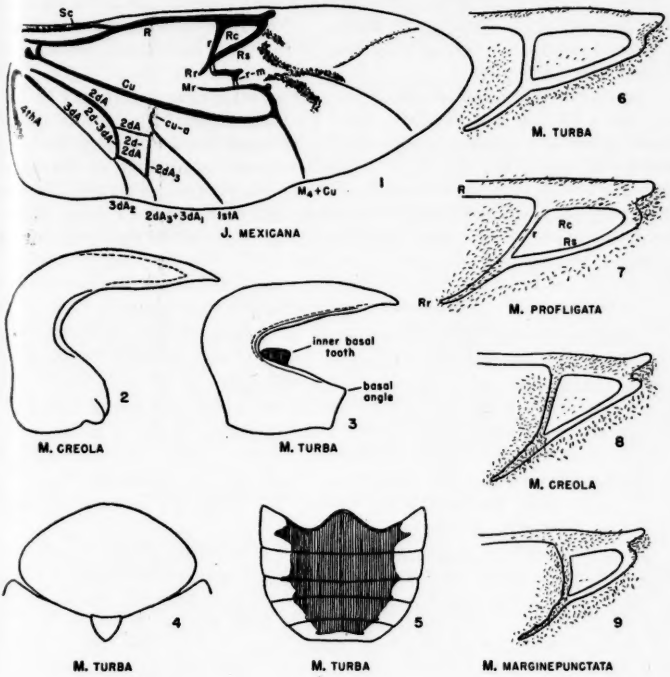
On the basis of these findings, *rubella* is rejected as occurring in North America, and *marginepunctata* is taken out of synonymy with it and placed in *Metriona, Strongylaspis* is believed to be a synonym based upon a study of the genotype, *Coptocycla bisignata,* and it is believed that *Erepsocassis* should be considered a synonym of *Metriona* based upon its description.

In the course of this study, two apparently undescribed species of *Metriona* have been found, one of which was first detected by some slight differences in the shape of the radial cell and radial recurrent from that of its closest relative, *profligata* Boheman. Differences in the wings were also noted in *creola* and the closely related *marginepunctata.*

Metriona turba n. sp.

Length 4.5 to 5 mm.; width 3.5 to 4 mm. Color above uniformly pale reddish yellow, shining. 8th, 9th, and 10th antennal segments darker than preceding ones and the 11th. Sides of pronotum rounded, nearly straight on posterior margin behind angles. Elytral punctures very fine; side margin of elytron laterad of 10th row of punctures uniformly transparent throughout its length and unpunctured. Underside of body nearly uniformly deep reddish black; abdomen with a broad parallel yellowish margin equal in width to about one-sixth or one-seventh that of the abdomen. Legs entirely yellow. Anterior tarsal claws of male each with a broad basal angulation; middle and posterior claws similarly angulate but each outer claw (fig. 3) with a short inner basal tooth; all claws of female with a broad basal angulation, the outer posterior claw of one female with a very short inner basal tooth similar to that of male but shorter; inner tooth absent in another female. Occasionally there are a few very fine crenulations or pectinations on sides of claw at base of basal angulation.

Holotype ♂, allotype ♀, 2 ♂ and 1 ♀ paratypes, San Bernardino Ranch, Cochise Co., Arizona. 3 ♂ and 2 ♀ paratypes, Baboquivari Mts., Arizona,



EXPLANATION OF FIGURES

1. *Jonthonota mexicana* Champion. Hind wing.
2. *Metriona creola* n. sp. Outer claw of middle tarsus of male.
3. *Metriona turba* n. sp. Outer claw of left posterior tarsus of male.
4. *Metriona turba.* n. sp. Pronotum of male.
5. *Metriona turba* n. sp. Abdomen of male.
6. *Metriona turba* n. sp. Radial cell.
7. *Metriona profligata* Boheman. Radial cell.
8. *Metriona creola* n. sp. Radial cell.
9. *Metriona marginepunctata* Schaeffer. Radial cell.

July 18, 1932, R. H. Beamer. 1 ♂ paratype Huachuca Mts., Arizona, Sunnyside Canyon, July 9, 1940, R. H. Beamer. Holotype, allotype, and paratypes in Snow Collection, University of Kansas; paratypes in collection of Illinois Natural History Survey.

Closely resembling *profligata* in size, color and appearance, it may be distinguished by the rounded latero-basal pronotal angles (fig. 4), and by its broad yellow abdominal margin (fig. 5). The radial crossvein (fig. 6) joins Radius (*R*) at nearly a 90° angle, while the corresponding angle of the radial crossvein (*r*) and Radius in *profligata* (fig. 7) is approximately 60°. It may be further distinguished from *profligata* by the latter species having microtrichia encroaching upon the radial recurrent (*Rr*), while the recurrent of *turba* is glabrous.

Metriona creola n. sp.

Length 6 mm.; width 4.5 mm. Color and shape extremely similar to that of *marginepunctata* Schaeffer. Margins of elytra unpunctured. Discal dark spot of elytron reduced so that one of the punctures of the fourth row only appears darker than the others. Venter black except pale margin of abdomen. All femora and middle and posterior tibiae nearly black; anterior tibiae reddish. Middle claws (fig. 2) untoothed, the inner claw with inner margin surface finely crenulate; both anterior and posterior claws toothed.

Holotype male, Vinton, La. December 25, 1939, R. H. Beamer, in Snow Collection, University of Kansas.

This species with *marginepunctata* differs from other Nearctic species of *Metriona* by having a fine dorsal microsculpture which renders the dorsum rather dull in appearance. The males of both species have the middle claws (fig. 2) untoothed, and *creola* differs chiefly from *marginepunctata* by having no large punctures in the broad margin laterad of the 10th row of elytral punctures. The radial recurrent in *creola* (fig. 8) is straight and continuous with remainder of radial sector and not sinuate as in *marginepunctata* (fig. 9).

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A NEW SERICOTHRIPS FROM ILLINOIS (Thysanoptera: Thripidae)

LEWIS J. STANNARD, JR.
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This distinctive new addition to the North American *Sericothrips* fauna, *Sericothrips smithi* sp. nov., was discovered nearly three years ago. Subsequent efforts to find it elsewhere in nearby areas have failed. As a result, little can be said of its habits except possibly that it is an inhabitant of prairie grasses and that it overwinters in the adult stage.

Its affinities are with the *staphylinus* group, that is, it belongs to that group of *Sericothrips* which have most of the abdominal terga, even across the meson, densely clothed with microsetae. Apparently, too, the *staphylinus* group is the only complex of the genus in which the species produce brachypterous forms as well as macropterous individuals. To date only the brachypterous phase of *smithi* has been found.

It is with pleasure that I name this species after its collector, Mr. P. W. Smith, a naturalist whose particular specialty is Herpetology. I am indebted to him for many collections of thrips from North America.

Sericothrips smithi sp. nov.

Female (brachypterous).—Length, distended, exclusive of antennae, about 0.85 mm. Body bicolored brown and yellow with orange subintegumental pigments. Pigment adjacent to the ocelli, red. Yellow: head; thorax; abdominal segment 1, 4, 5, 6, 8, 9 and 10; wing pads; legs; antennal segments 1, 2, most of 3, and basal half of 4 and 5. Brown: abdominal segments 2, 3, and 7; a transverse line near the anterior margin on abdominal terga 4, 5 and 6; tip of the mouth cone; antennal segments 3 near the apex, apical half of 4 and 5, and all of 6, 7 and 8.

Head, transverse, typical of genus; mouth cone extending full length of the prothorax; antennal segment 6, fig. 1, with a conspicuous pedicel, about as in the macropterous form of cingulatus, much more pronounced than in *pedicellatus* (compare Hood 1927B, plate XIV, fig. 1); antennal segment 8 longer than 7.

Striae of prothorax similar to those of *annulipes* (See Hood 1927 A, plate XX, fig. 4) but even farther apart in the anterior region, not as closely spaced as in *cingulatus* and *staphylinus*; epimeral spines small, no longer than other prothoracic spines.

Abdominal terga and sterna almost entirely covered with microsetae; posterior margins of sterna nearly straight, fig. 2, not incut at region of posterior sternal setae.

Holotype.—Female. Greenup, Ill., March 5, 1949, (P. W. Smith); from prairie sod, specimens recovered by a Berlese funnel extractor. **Paratypes.**—5 ♀ ♀, same data as for holotype.

The types have been deposited in the collection of the Illinois Natural History Survey.

From the European *Sericothrips staphylinus* Haliday and its varieties, *bicornis* (Karny) and *gracilicornis* (Williams), and from the North American *Sericothrips cingulatus* Hinds, *smithi* may be distinguished by the characteristic contour of the posterior margins of the intermediate abdominal sterna. Both *staphylinus* and *cingulatus* have the sternal margins deeply incut at each of the posterior setae, fig. 3; *smithi* has scarcely any indentation at the region of these posterior setae, fig. 2. In color, *smithi* is much lighter than either *staphylinus* or *cingulatus*. The body of *staphylinus* is almost entirely brown; *cingulatus* is predominantly brown except for abdominal segments 4, 5 and 6; *smithi*, on the other hand, has only abdominal segments 2, 3 and 7 brown.

Of the New World *Sericothrips*, only *cingulatus* and *smithi* belong to the *staphylinus* group. All other species lack microsetae on most of the meson of the intermediate abdominal terga and therefore are separated from this group by a conspicuous characteristic.

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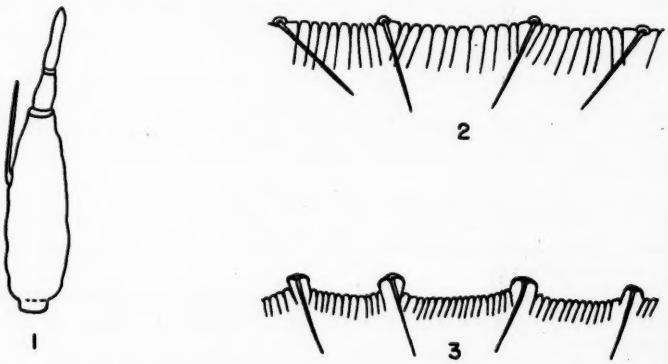
———1927B.—New Thysanoptera from the United States. Journ. N. Y. Ent. Soc., 35:145, plate XIV, fig. 1. Illustration of antenna of *Sericothrips pedicellatus*.



EXPLANATION OF ILLUSTRATIONS

Sericothrips smithi new species. Fig. 1, antennal segments 6, 7 and 8. Fig. 2, median section of posterior margin of 5th abdominal sternum.

Sericothrips cingulatus Hinds. Fig. 3, median section of posterior margin of 5th abdominal sternum.

AN INTERESTING NEW GERRID FROM MADAGASCAR (Hemiptera)

H. B. HUNGERFORD[1]

Some years ago I received a curious water strider from Madagascar that is quite unlike any form known to me from Madagascar or Africa. With eighteen or more species of Gerridae known from Madagascar it seems strange that this striking form should have remained unknown.

It belongs to the subfamily Ptilomerinae and its closest relatives belong to the genera *Potamometra* Bianchi and *Potamometropsis* Lundblad. The former represented by two species from China, Korea, and Indo-China and the latter by a single species from Sumatra.

This new species will not run out satisfactorily at any terminal point in Dr. Esaki's key to genera of Ptilomerinae.[2]

The females have the abdomen invaginated as in *Potamometra* but the males have the genital segments smaller and shaped like a male from Sumatra that I have identified as *Potamometropsis obnubila* Lundb.

I, therefore, propose for this new species the genus:

Potamometroides new genus

Apterous form. Body nearly cylindrical, slightly compressed dorsoventrally. Males with body about three times as long as broad. Females only twice as long as broad. Females a little broader but shorter than the males. First antennal segment longer than other three combined. The antennae of males about as long as the body and longer than the body in female. Front femur longer than the thorax on its median line. Middle and hind femora elongate about twice the length of the body in the female. Apex of front tibia produced. Metanotum but faintly sulcated along the median longitudinal line, less than half as long as mesonotum and female lacks the median projection characteristic of *Potamometra*. Posterior coxae not spined. Posterior acetabula dorsal to abdomen and, in the female, produced into a long straight sclerotized process. Female abdomen invaginated and scarcely visible from above. Male abdomen broader and a little longer than the genital segments. Male claspers often conspicuously protruding.

Genotype: *P. madagascariensis* described below.

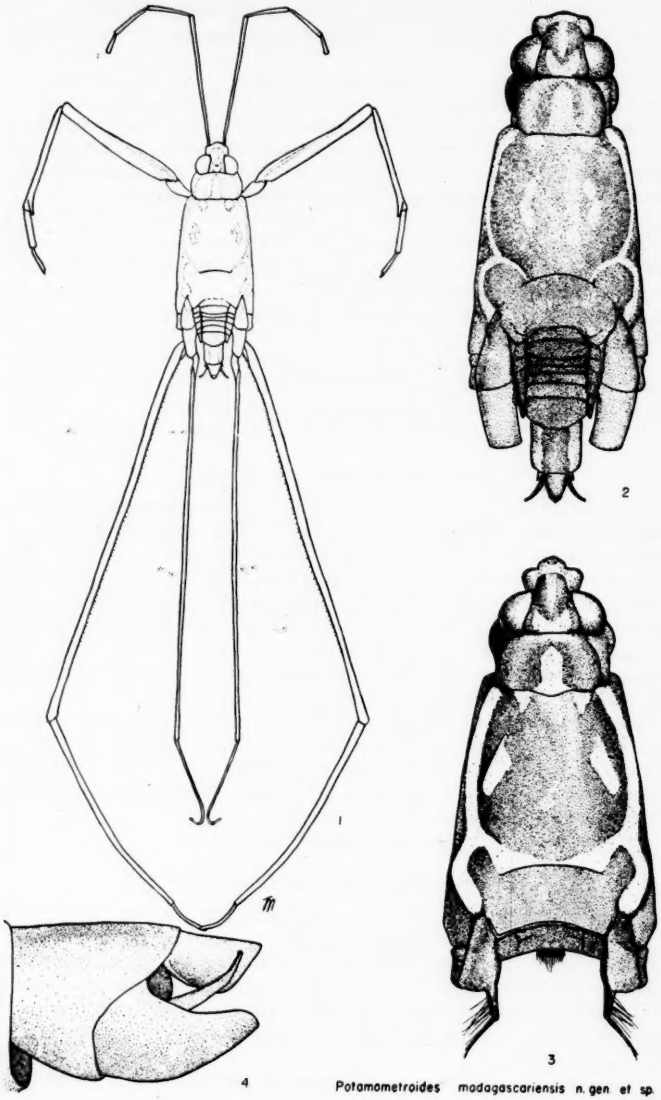
Potamometroides madagascariensis new sp.

Size: Length of male 6.09 mm.; greatest width 2.1 mm.; length of female 4.75 mm.; greatest width 2.6 mm.

Color: Body black, lateral margin of the mesonotum with a silver pilose band that bifurcates behind and four silvery spots on the dorsum. The sides of the head, a band across anterior part of frons, a broad lunate spot on the vertex, a median broad conate band on the pronotum that does not reach the

[1] Contribution No. 775 from the Department of Entomology, University of Kansas, Lawrence.

[2] Esaki, Teiso. 1927. EOS, Revista Española de Entomologia III, pp. 253-4.



Potamometroides madagascariensis n. gen. et sp.

anterior margin, sides of the pronotum, acetabula, coxae and trochanters, orange yellow. Front femora orange yellow with a longitudinal black band, middle femora more or less orange yellow on basal half. Antennae and remaining leg segments black. Abdominal venter of female yellow. Basal segments of abdominal venter of male black, others including genital segments yellow.

Structural Characteristics: Antennal segmental formula: 1st: 2nd: 3rd: 4th:: 25: 8.3:8.3:4.75. Front leg segments: Femur: tibia: 1st tarsal: 2nd tarsal:: 26.5:22.6:7:4.5. Middle leg segments: Femur: tibia: tarsus: 74:40.5:10.2. Hind leg segments: Femur: tibia: tarsus:: 69:19.5:2.2 (♂). The middle legs are not only longer but stouter than the hind legs. The trochanters and femora of the middle legs of the male have many short stout spines on their caudal margin. The females lack these spines but both middle and hind femora may possess numerous scattered long slender hairs. Head including the eyes not quite as wide as the prothorax. The interocular space, at the rear, wider than the eye. Beak short not reaching distal end of front coxae. Female abdomen invaginated, the last two ventral segments longer than the others. The last two ventral abdominal segments of the male longer than the others. The last one as long as the three preceding. The last two abdominal tergites of the male longer than the others, the last one as long as the three preceding. The first genital segment of the male appears cylindrical as viewed from above and is about as long as the last two abdominal segments. In side view the first genital of the male is seen to be ventrally constricted at its base. The claspers are black and long and may be almost entirely withdrawn. (See drawings).

Location of types: Described from holotype male, allotype, 1 male and 9 female paratypes bearing the following label: "Madagascar, Taananarive, Briglet 1937, C. Lamberton." In the Snow Collections, University of Kansas.

Comparative notes: The species is smaller than *Potamometra berezowskii* Bianchi or *P. tibetensis* Esaki. Since *Potamometropsis obnubila* Lundblad was described from a single female and its length not given, I cannot compare the size of this new species with it. I have a male, however, from Sumatra that I believe is Dr. Lundblad's species. It is about the same size as the male of this new species. However, its dorsal surface is more pilose, its eyes less rounded and less protuberant, their inner margins nearly straight and parallel while in *P. madagascariensis*, the eyes are prominently rounded and distinctly emarginated in their inner margin. The rear margin of the pronotum in the Sumatra male is broadly emarginated, whereas in the new species it is straight in the male and slightly medianly produced in the female. When we compare the females of *P. madagascariensis* with the female type of *Potamometropsis obnubila* Lundblad, they do not appear to be congeneric. The invaginated abdomen of the former, its more conspicuous eyes, the equal of the second and third antennal segments, the projection on the hind acetabula, the much longer hind coxae, and the absence of the broad connexival flaps of *P. obnubila* Lundblad all indicate significant differences.

COMPARATIVE STUDIES OF THE MALE GENITALIA OF THE HEMIPTERA (Homoptera-Heteroptera)[1]

EDWIN P. MARKS

This paper presents the results of a comparative morphological study of the male genitalia of the Hemiptera (Homoptera-Heteroptera). Many different names have been given to the structures that make up the copulatory apparatus of the males of the Hemiptera. This situation has led to much confusion among both the taxonomists and the morphologists as to a nomenclature which is both morphologically accurate and suitable for the use of the taxonomist.

The present study was taken up at the suggestion of Dr. C. D. Michener whose interest in the homologies of the genitalia throughout the various orders of insects resulted in a paper suggesting a uniform nomenclature based on interordinal homologies of the structures which make up the genitalia (Michener, 1944). The nomenclature suggested in that paper will be followed insofar as is possible.

Considerable work has been done on this problem and many speculations have been made concerning the homologies of the structures found in the genitalia of the Hemiptera. Most of this work has been summarized and evaluated by Singh Pruthi (1925) who has published a comprehensive study of the genitalia of the Hemiptera. His numerous figures, representing most of the major groups, are excellent and should be consulted by anyone wishing to study such genitalia in detail. The comprehensibility of his paper, however, is somewhat limited by the system of nomenclature used and by the vagueness of the author regarding the homologies of some of the structures involved.

Snodgrass (1935) in his excellent work on insect morphology gives the genitalia of the Hemiptera only a superficial treatment and suggests that further study is needed to determine the homologies of the parts.

The present study was undertaken to coordinate the works of these three authors and to point out the homologies existing between the genitalic structures of the Homoptera and Heteroptera. A nomenclature is proposed for these parts which, it is hoped, will be acceptable to the taxonomist and the morphologist alike. The origin of the somewhat complicated internal capsule of the Heteroptera from the simple condition existing in the Homoptera is also explained on a comparative morphological basis. It should be emphasized that the genital capsule of the Hemiptera is the ninth segment and that the internal capsule is entirely different in structure. Table I compares the nomenclatures used by the three previously mentioned authors and contains certain addition which now seem necessary.

In the present study, members of the following families were examined: Cicadidae, Fulgoridae, Psyllidae, Cicadellidae, Cercopidae, Membracidae,

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[1] Contribution No. 766 from the Department of Entomology of the University of Kansas.

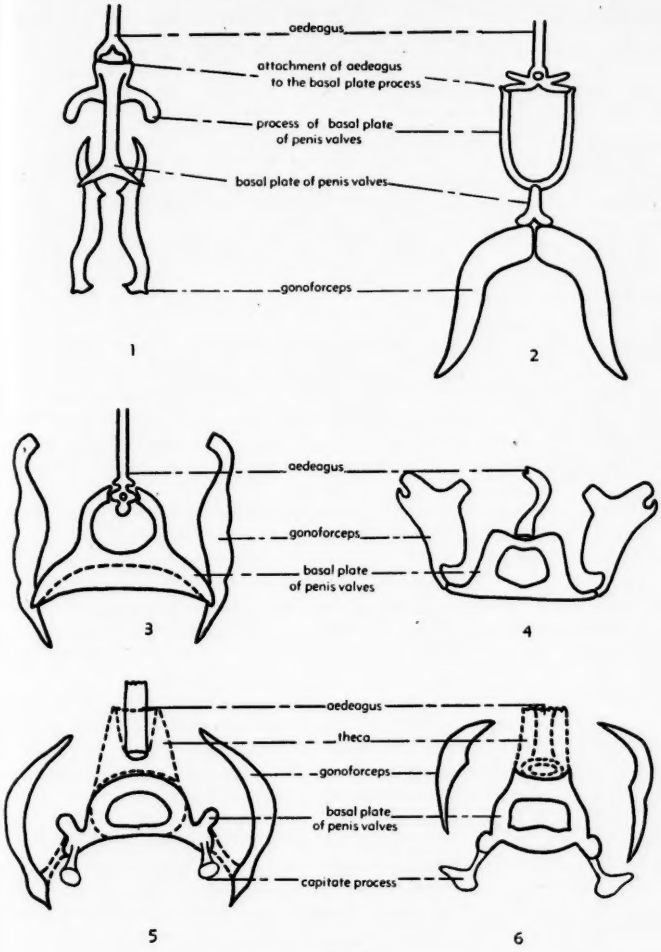

PLATE I

EXPLANATION OF PLATES

Plate I. Ventral view of hard parts of male genitalia dissected out and laid out flat.

Fig. 1. *Oecleus snowi* Ball (Fulgoridae)
Fig. 2. *Pachypsylla venusta* Osten Sacken (Psyllidae)
Fig. 3. *Leparonia quadrangularis* (Say) (Cercopidae)
Fig. 4. *Locris* sp. (Cercopidae)
Fig. 5. *Pentacora signoretti* (Guérin-Méneville) (Saldidae)
Fig. 6. Miris dolobratus (Linnaeus) (Miridae)

TABLE I

SINGH PRUTHI	SNODGRASS	MICHENER	MARKS
parameres	harpagones	gonoforceps	gonoforceps
basal plate	phallobase (basal plate no. 1)	fused basal portions of the gonopophyses	basal plate of the penis valves
basal plate prolongation	basal plate no. 2	———	lateral process of the basal plate
phallosoma	phallobase	———	theca
aedeagus	aedeagus	aedeagus	aedeagus
———	———	———	capitate process
segmental membrane	segmental membrane	segmental membrane	segmental membrane
genital chamber	genital chamber	———	genital chamber (internal capsule)
ninth sternum	ninth sternum	ninth sternum	ninth sternum

Saldidae, Miridae, Pentatomidae, Lygaeidae, Gerridae, and Corixidae. In all over a hundred dissections were made. From this series six insects were selected as representing a graded series depicting the homologies of the structures described in this paper. The specimens were cleared in warm ten percent caustic soda, washed in weak acetic acid, and stained in acid fuchsin. The dissections were made in a drop of glycerine under a binocular microscope.

In a hypothetical primative homopteron the genitalia may be described as follows; The gonoforceps, representing the fused gonocoxite and gonostylus or perhaps the gonocoxite alone, are articulated to the ventral, caudal edge of the ninth sternum. The basal plate of the penis valves, representing the fused proximal portions of the gonopophyses, is articulated to the gonoforceps at the point of attachment of the latter to the ninth sternum. From this point, lying in the segmental membrane, it projects dorsad articulating at the dorsal extremity with the base of the aedeagus. The latter extends caudad and is composed of the primative penis and the fused distal portion of the penis valves (i.e. the distal portions of the gonopophyses). The closing or segmental membrane between the margin of the ninth sternum and the base of the tenth is attached at the edges of the ninth segment and is produced caudad to form more or less of a theca around the aedeagus.

The condition described above is closely approximated in the fulgorid, *Oeclus snowi* Ball. As seen in fig. 1 Plate I, in which the hard parts of the genitalia have been dissected out and laid flat, the gonoforceps are articulated to the lower edge of the basal plate of the penis valves. This plate is articulated at its distal end to the base of the aedeagus. Just below this point of articulation two lateral processes belonging to the basal plate are present. As will be noted in fig. 7 plate II, the gonoforceps are attached to the segmental membrane just behind the ninth sternum while the basal plate and the basal portion of the aedeagus have moved inward and have lost their connection to the segmental membrane. In addition to this, the venter of the tenth segment is produced to form a dorsal support for the aedeagus. These latter adaptations, however, appear to be secondary in nature.

Fig. 2 plate I shows the hard parts of the genitalia of *Pachypsylla venusta* Osten Sacken dissected out and arranged in a comparable position. Here it

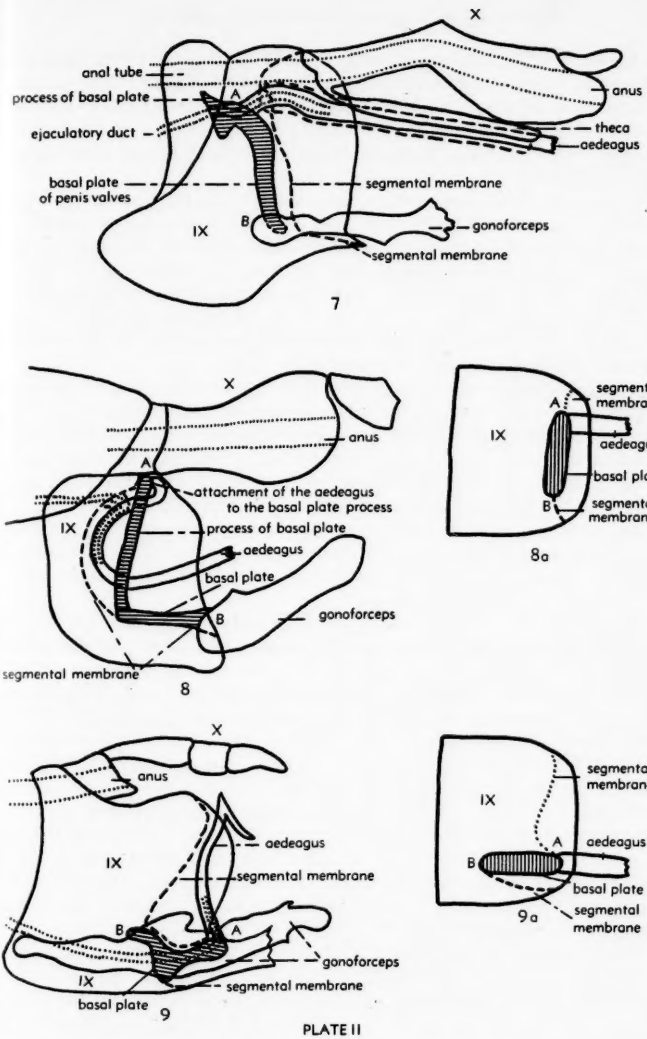

PLATE II

Plate II. Lateral view of the ninth segment and genital appendages.
Fig. 7. *Oecleus snowi* Ball (Fulgoridae)
Fig. 8. *Pachypsylla venusta* Osten Sacken (Psyllidae)
Fig. 8a. Diagram illustrating positions of the aedeagus and basal plate as seen in fig. 8.
Fig. 9. *Leparonia quadrangularis* (Say) (Cercopidae)
Fig. 9a. Diagram illustrating positions of the aedeagus and basal plate as seen in fig. 9.

will be seen that, as before, the gonoforceps are articulated to the basal plate of the penis valves which have been greatly reduced. The lateral processes of the basal plate are greatly elongated and have become articulated to the latter by a secondary articulation. At the distal ends of the elongated basal plate processes, the aedeagus is articulated, having shifted upward from the end of the basal plate.

In the cercopid, *Leparonia quadrangularis* (Say), as is seen in fig. 3 plate I, the basal plate is still farther modified until it appears as a bar connecting the gonoforceps. The processes, again fused with the basal plate and articulating with the base of the aedeagus, form an almost complete ring. In another cercopid *Locris* sp. fig. 4 plate 1, this trend of fusion and reduction is continued resulting in a complete ring with the aedeagus attached to the outer margin. It is not too clear, however, whether the basal portion of the aedeagus is actually incorporated in the ring or not.

It is of interest to note that the three above types of genital structure represent the three major types of homopteron genitalia and that all of those observed by the author or figured by Singh Pruthi can easily be related to one of these three types. The type found in the cicada is perhaps the most difficult to interpret. In this case the gonoforceps are absent. The basal plate of the penis valves is present however and resembles that of the fulgorid. The aedeagus in the specimens examined is membranous. The presence of a basal plate in the position typical of the fulgorid type indicates a relationship to the latter, the major differentiation being the reduction of the gonoforceps and the desclerotization of the aedeagus.

In relating the heteropteron type of genitalia to the homopteron type described above, several difficulties are encountered. These may be resolved most easily if we limit our observations for the present to the sclerotized ring found at the base of the internal capsule. This ring, figs. 5 and 6 Plate I, as can be seen by comparison with fig. 4, is homologous with the basal plate of the penis valves of the Homoptera. Fig. 5 plate 1 shows the basal plate of *Pentacora signoretti* (Guérin-Méneville), a saldid. The connection of the basal plate to the gonoforceps has become ligamentous. The fused penis valves of the aedeagus are no longer in evidence, the connection of the aedeagus to the basal plate being membranous and connecting around the edges of the ring. A secondary structure, which will be called the capitate process, has developed near the point of attachment of each gonoforcep to the basal plate. The homology of the basal plate of the Heteroptera to that found in the Homoptera is, however, quite evident.

In the type of genitalia found in the mirid, *Miris dolobratus* (Linnaeus) fig. 6 plate I, and, indeed in several of the other groups of Heteroptera examined, the attachment of the gonoforceps to the basal plate is very delicate and in some species appears to be completely missing. The position of the capitate processes, however, will serve to mark the original point of attachment. The attachment of the aedeagus to the basal plate is essentially similar to that found in the saldid. There is considerable variation in the different groups of the Heteroptera as can be seen from examining Singh Pruthi's plates. An understanding of the mirid type of structure will enable the reader to determine the necessary homologies for most of the group.

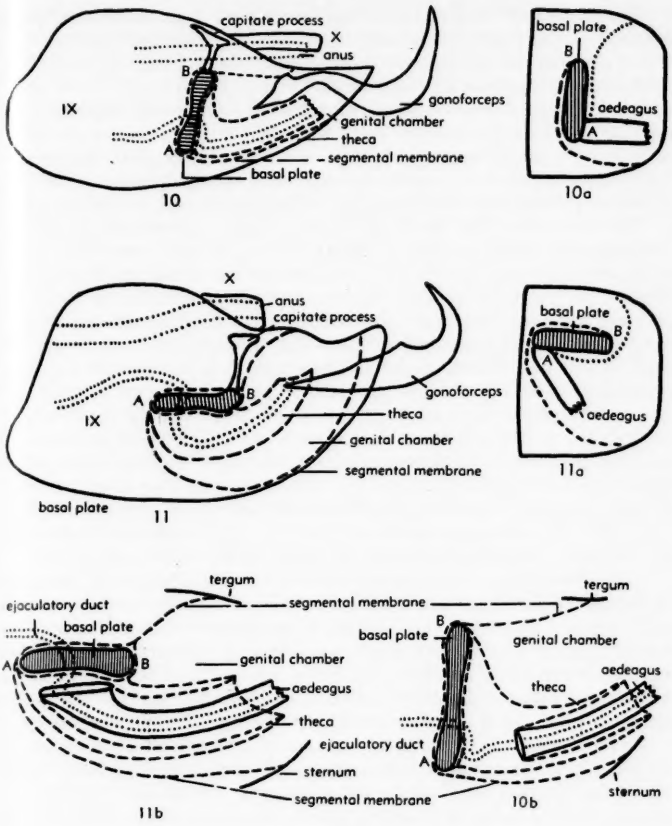

PLATE III

Plate III. Lateral view of ninth segment and genital appendages

Fig. 10. *Pentacora signoretti* (Guérin-Menéville) (Saldidae)

Fig. 10a. Diagram illustrating the positions of the aedeagus and basal plate as seen in fig. 10.

Fig. 10b. Detail of genital chamber as seen in fig. 10.

Fig. 11. *Miris dolobratus* (Linnaeus) (Miridae)

Fig. 11a. Diagram illustrating positions of the aedeagus and basal plate as seen in fig. 11.

Fig. 11b. Detail of the genital chamber as seen in fig. 11.

At this point the author wishes to make it clear that the series of insects described in this paper is not to be regarded as a phylogenetic series. These insects were selected because they show a graded series of steps in the development of the hemipteron type of genitalia. The author does imply that the sequence leading to the hemipteron type followed a similar developmental series. The ancestoral types are of course extinct and therefore unavailable for study but the phylogenetic sidelines have preserved enough of the intermediate stages in genitalic structure so that the homologies between the more primative Homoptera and the specialized Heteroptera can be established.

The contention that the forms discussed above show a developmental progression is strengthened by a study of the segmental membrane and the corresponding changes in the ninth segment and the basal plate. Plates II and III show diagrammatically the orientation of these parts in the normal resting position. Accompanying each of these figures is a diagram showing the relative positions of the genital parts. Figs. 7 and 8 Plate II show lateral views of a fulgorid and a psyllid respectively. The situation in these two insects is essentially the same and is diagrammed in fig. 8a. The basal plate is shaded and shown as a straight bar to facilitate visualization. The point of articulation of the aedeagus to the basal plate is marked as point A. The point of articulation of the basal plate to the gonoforceps is marked as point B. The position of the membrane which extends upward from point A to the base of the tenth segment is shown as a dotted line. The membrane which extends downward from point B to the posterior margin of the ninth sternum is shown as a broken line. In these insects the basal plate lies in the dorsoventral plane.

Fig. 9 Plate II shows the genitalia of a cercopid. In this case the basal plate of the penis valves has rotated ninety degrees and now lies in the anteroposterior plane. The dorsal portion of the segmental membrane extends downward and inward while the ventral portion extends upward and inward. The basal plate and the gonoforceps have moved inward, the latter being attached to the segmental membrane. Fig. 9a is a diagram showing the rotation that has taken place and the relative positions of the segmental membranes.

In the saldid, fig. 10 plates III, the basal plate has rotated another ninety degrees, again lying again in the dorsoventral plane but in a reversed position. The dorsal portion of the segmental membrane extends downward and inward, becoming attached to the edges of the basal plate. It now forms the dorsal wall of the genital chamber and is bulged outward around the base of the aedeagus. The ventral portion of the segmental membrane extends inward and upward, forming the ventral wall of the genital chamber and covering the anterior side of the basal plate. Coinciding with this development of a genital chamber, the ventral edge of the ninth sternum protrudes upward and outward, carrying with it the gonoforceps which are articulated to it. As a result the opening of the genital chamber lies on the upper surface of the ninth segment. With this change, the gonoforceps have been pulled away somewhat from the basal plate. The capitate processes extend upward toward the dorsal wall of the ninth segment. Fig. 10a illustrates this rotation and the relative positions of the segmental membrane. With the pulling away of the gonoforceps from the basal plate and the membranous condition of the base of the aedeagus, the articulation point of the gonoforceps to the basal plate

is marked by the position of the capitate process. Similarly the articulation point of the aedeagus to the basal plate is marked by the position of the ejaculatory duct which is plainly visible in all cases, and which in all of the hemiptera examined passes between the processes of the basal plate before entering the base of the aedeagus. These two structures thus can be used as landmarks in following the rotation of the basal plate in the formation of the genital chamber.

In the mirid type of genitalia, fig. II Plate III, the basal plate undergoes further rotation and now lies again in an anteroposterior plane, having rotated a full two hundred and seventy degrees from the primative position found in the fulgorid. The rotation which results in the formation of the genital chamber can be visualized by following the series of figures: 8a, 9a, 10a, and 11a. The rotation illustrated in each case is ninety degrees, the total thus being two hundred and seventy degrees occurring between figures 8a and 11a. The attachment of the gonoforceps to the basal plate has become very delicate and in some cases appears to be absent entirely. The walls of the genital chamber which are membranous in the saldid have become sclerotized forming a definite internal capsule, often being firmly attached to the ventral wall of the ninth sternum. The aedeagus is a long membranous tube which is telescoped in the resting position so that its true structure can be determined only by teasing it out to its full length. There is some question as to just what structures are involved in the makeup of the hemipterous aedeagus. The aedeagus of the homopteron is well sclerotized, in all probability representing the fused penis valves and the primative penis which originates as an evagination of the segmental membrane. In the Hemiptera the penis valves have become desclerotized or are absent. Also the dorsal portion of the segmental membrane, due to the rotation of the basal plate, has become adnate to the latter and bulges outward forming a theca around the base of the aedeagus. These developments make it difficult to determine whether the aedeagal structure of the hemipteron is entirely homologous to that of the homopteron, or whether the dorsal portion of the segmental membrane enters into its consruction. Further study will be necessary to clarify this point. The work of F. S. Truxal (in press) on the genitalia of the Notonectidae shows a progressive reduction of the basal plate accompanied by an increase in the complexity of the aedeagus, showing a continuation of the line of development suggested here.

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A PRELIMINARY COMPARATIVE STUDY OF THE MALE GENITALIA OF ANDRENIDAE (Hymenoptera, Apoidea)[1]

JEROME G. ROZEN

The purposes of this paper are two fold: first to establish the intergeneric homologies of the male genitalia of the Andrenidae and secondly to suggest phylogenetic relationships between the andrenid genera on the basis of genitalic characteristics. Although the homologies were easily established, the second objective could be fulfilled only to the extent of indicating paths for further study of this sort. In many cases only one species of a genus was examined. However, when there was thought to be a great deal of diversity among the species within a genus, more than one species was studied in order that this paper might give a fairly accurate, if not extensive, picture of the male genitalia of the andrenid bees.

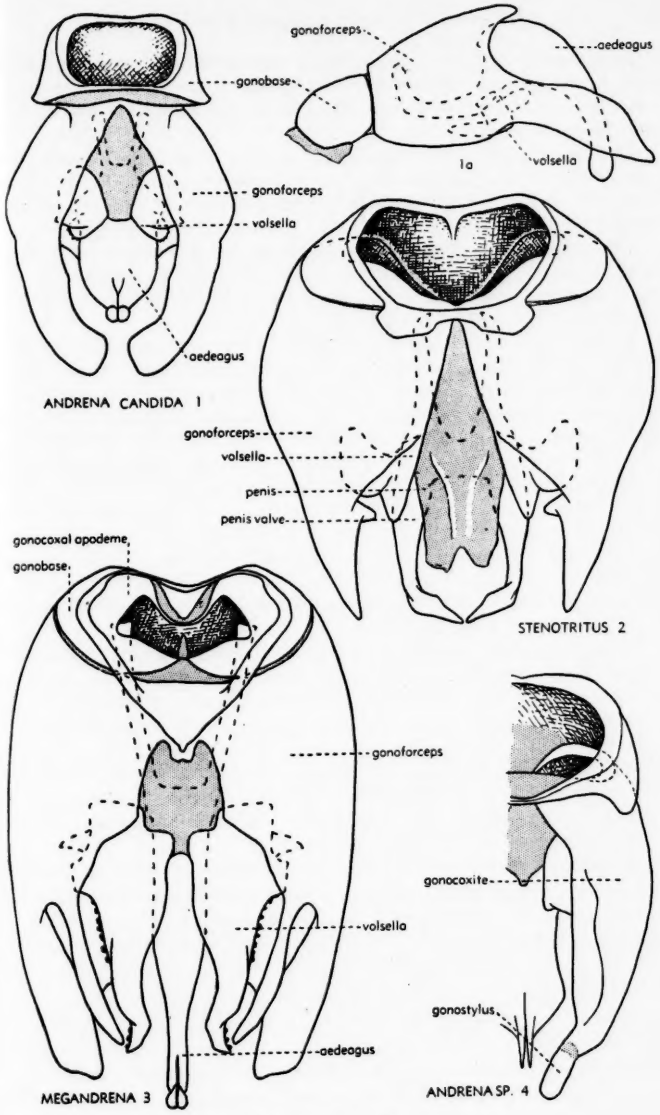
It was not possible to dissect examples of all the genera in the Andrenidae, since some were not available. The following are the species whose genitalia were examined: *Andrena candida* Smith (fig. 1, 1a), *Megandrena enceliae* Cockerell (fig. 3), *Melitturga praestans syriaca* Friese (fig. 10), *Psaenythia cockerellii* (Dunning) (fig. 7), *Meliturgula braunsi* Friese (fig. 6), *Pseudopanurgus aethops* (Cresson), *P. innuptus* (Cockerell) (fig. 8), *Epimethea kuzentzovi* Cockerell (fig. 11), *Camptopoeum rufiventre* Morawitz (fig. 12), *Perdita californica* (Cresson), *P.* (*Cockerellia*) sp. (fig. 16), *Hypomacrotera callops* Cockerell & Porter, *H. subalpina* (Cockerell) (fig. 17), *Calliopsis andreniformis* Smith, *C. coloradensis* Cresson (fig. 14, 14a), *Panurgus banksianus* (Kirby) (fig. 9), *Panurginus occidentalis* Crawford (fig. 13), *Nomadopsis zebrata* (Cresson) (fig. 15), *N. scutellaris* (Fowler), *Acamptopeoum maculatum* (Spinola) *A. hirsutulum* (Spinola) *A. submetallicum* (Spinola), and *Protoxea gloriosa* (Fox) (fig. 5). The genitalia of a member of each genus is figured except where the genitalic types of two genera are so very close that the genitalia of one can represent the other.

The nomenclature used for the genitalic structures follows that proposed by Michener (1944 and 1944a), and likewise Michener's (1944a) classification of the Andrenidae is used.

DESCRIPTION OF GENITALIC STRUCTURES

Gonobase: This structure is represented as an annular sclerite in all the species of the Andreninae studied as well as in those figured by previous authors. The gonobase of *Protoxea gloriosa* is also well developed but differs from that of both *Andrena candida* and *Megandrena enceliae* in that it narrows anteriorly. In this species the ventral membrane which connects the gonobase to the abdomen is spiculated and is extremely large, being longer than the gonopods themselves. When the genitalia is retracted within the body, the membrane surrounds the genitalia both ventrally and laterally as a large convoluted mass.

[1] Contribution No. 767 from the Department of Entomology, University of Kansas.



EXPLANATION OF PLATES

Plate I

Fig. 1. *Andrena candida* Smith, ventral view of male genitalia.
Fig. 1a. *Andrena candida* Smith, lateral view of male genitalia.
Fig. 2. *Stenotritus pubescens* (Smith), ventral view of male genitalia.
Fig. 3. *Megandrena enceliae* Cockerell, ventral view of male genitalia.
Fig. 4. *Andrena* sp., ventral view of male genitalia.

In all the Panurginae the gonobase is entirely absent, a condition which is not known to occur elsewhere in the Apoidea except in *Apis*. Presumably it has become membranous since there is no indication of it having fused with the gonocoxites.

Gonocoxites: The variation between the gonocoxites of the various genera appears mainly in relation to the gonocoxal apodeme, which is the anterior, fused continuation of the gonocoxites into the body or into the gonobase when the latter is present.

The gonocoxal apodeme is present in all the genera but in general is better developed in the Panurginae, where the gonobase is missing. Thus this apodeme is very small in both *Andrena candida* and *Protoxea gloriosa*, although in *Megandrena enceliae* it is well developed.

In Panurginae, *Meliturgula braunsi* has a very small apodeme, which is evident only on the lateral edges of the gonocoxites. *Psaenythea cockerellii* has a large gonocoxal apodeme, which is inflected, leaving a very small genital foramen. *Pseudopanurgus innuptus* has a very small gonocoxal apodeme; another species, *P. aethops*, has a gonocoxal apodeme which, although being somewhat smaller than that of *Psaenythea cockerellii*, is inflected in a similar fashion. *Camptopoeum rufiventre, Melitturga p. syriaca, Epimethea kuznetzovi, Panurginus occidentalis,* and *Panurgus banksianus* each has a large gonocoxal apodeme with a deep, antero-ventral, median indentation, which nearly bisects the apodeme. In *Perdita californica, P.* (Cockerellia) sp., *Nomadopsis zebrata, N. scutellaris, Acamptopoeum maculatum, A. hirsutulum, A. submetallicum, Hypomacrotera callops,* and *H. subalpina* there is no such deep anterior indentation.

Attention should be paid to the general shape of the gonocoxites. Thus, in the species of *Camptopoeum, Melitturga, Epimethea, Panurginus,* and *Panurgus* which were examined, the gonocoxites were found to be very similar, as can readily be seen from the figures. The gonocoxites of *Nomadopsis scutellaris, Calliopsis andreniformis, Hypomacrotera callops* and *subalpina*, and *A. camptopoeum maculatum* and *hirsutulum* are all extremely similar, while those of *Nomadopsis zebrata, Calliopsis coloradensis* and *Acamptopoeum submetallicum*, although similar to each other, are quite different from the species above mentioned.

Gonostyli: There is some question whether or not the gonostyli are usually represented in the *Andrena* and perhaps *Megandrena*, for an unknown species of *Andrena* was dissected and found to have very definite gonostylus-like structures (fig. 4) arising from the distal ends of what are generally believed to be gonostyli. These gonostylus-like projections are only partly fused with the rest of the genitalia and are less heavily sclerotized. If these structures are truly the gonostyli, it would have to be assumed that what are now termed the gonostyli are a prolongation of the gonocoxites. However, a more extensive study, probably including a study of the muscles, would have to be made before such a question could be solved. Until this is done, it seems better to follow the conventional terminology.

In both *Andrena candida* and *Megandrena enceliae* the gonostyli are completely fused to the gonocoxites and leave no indication of where this line of

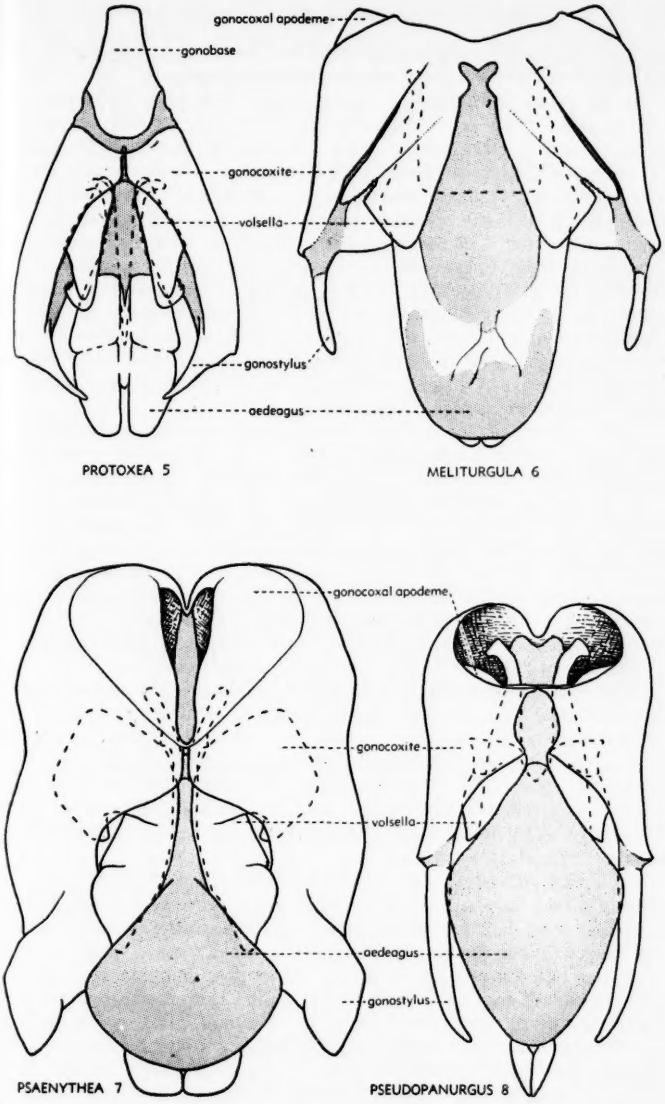


Plate II

Fig. 5. ***Protoxea gloriosa*** (Fox), ventral view of male genitalia.
Fig. 6. ***Meliturgula braunsi*** Friese, ventral view of male genitalia.
Fig. 7. ***Psaenythea cockerellii*** (Dunning), ventral view of male genitalia.
Fig. 8. ***Pseudopanurgus innuptus*** (Cockerell), ventral view of male genitalia.

fusion might be. The gonostyli of *Protoxea gloriosa* are incompletely fused but, nevertheless, seem to be quite rigidly directed inwards.

In the species of *Melitturga, Camptopoeum, Panurgus, Meliturgula, Epimethea,* and *Panurginus* which were studied, the gonostyli are slender and are only partly fused to the rest of the genitalia. While *Pseudopanurgus innuptus* has a fairly thin gonostyli, *P. aethops* has gonostyli which are considerably thicker, so that *Pseudopanurgus* does not fit in the above group. The gonostyli of *Psaenthea cockerellii* are thick and are fused to the gonocoxites. In *Perdita* (*Cockerellia*) sp. the gonostyli are completely fused to the gonocoxites. However, *Perdita californica* indicates that the volsellae and the gonostyli are attached in line to the gonocoxites. The gonostyli in the examined species of *Calliopsis*, (except perhaps *C. coloradensis*), *Nomadopsis, Hypomacrotera*, and *Acamptopoeum* (except perhaps for *A. submetallicum*), appear to be completely absent. However, *Acamptopoeum submetallicum* and *Calliopsis coloradensis* have what are probably gonostyli arising from the posterior lateral edges of the gonocoxites.

Penis valves and penis: These two structures are discussed together because one of the pronounced differences between the various genera is concerned primarily with whether or not these structures are fused to each other.

In the species of *Andrena, Megandrena, Psaenythea, Pseudopanurgus, Meliturgula, Perdita*, and *Protoxea* which were studied the penis valves and penis are fused. The penis is separated from the penis valves in the rest of the genera except in *Panurgus banksianus*. This species has a condition somewhat intermediate. However, since the penis valves extend considerably beyond the penis, it would appear that the condition of these structures is similar to that found in the genera with the penis valves separated from the penis.

Melitturga p. syriaca is unique in having a very small penis.

There is a strong similarity between the penis valves of *Calliopsis andreniformis, Nomadopsis scutellaris, A. camptopoeum hirsutulum, A. maculatum, Hypomacrotera callops,* and *H. subalpinus;* all of these species have large penis valves that are greatly expanded and contorted. On the other hand, *Nomadopsis zebrata, Calliopsis coloradensis,* and to some extent *Acamptopoeum submetallicum* have penis valves that are alike being large but not contorted and expanded, a condition which is quite different from the type of penis valve above mentioned.

Volsellae: Although in the typical Hymenoptera each of these structures is divided into two parts, called the cuspus and digitus by Snodgrass (1941), the volsellae of the Andrenidae seem always to have the digitus and cuspus fused, even though the line of fusion may be weak. In many of the genera the cuspus and digitus retain their identity, since they maintain their apposable position to one another and the line of fusion can be seen between them. However, in the species of *Megandrena, Protoxea, Meliturgula, Calliopsis, Nomadopsis, Acamptopoeum,* and *Hypomacrotera* which were studied the volsellae have been considerably modified. In *Megandrena enceliae* the volsellae are elongated and the cuspus can not be distinguished from the digitus. In *Protoxea gloriosa* these two parts are obscure. In the representatives of *Calliopsis, Hypomacrotera, Acamptopoeum,* and *Nomadopsis* which were examined the volsellae have a tendency to fuse to each other and the cuspus

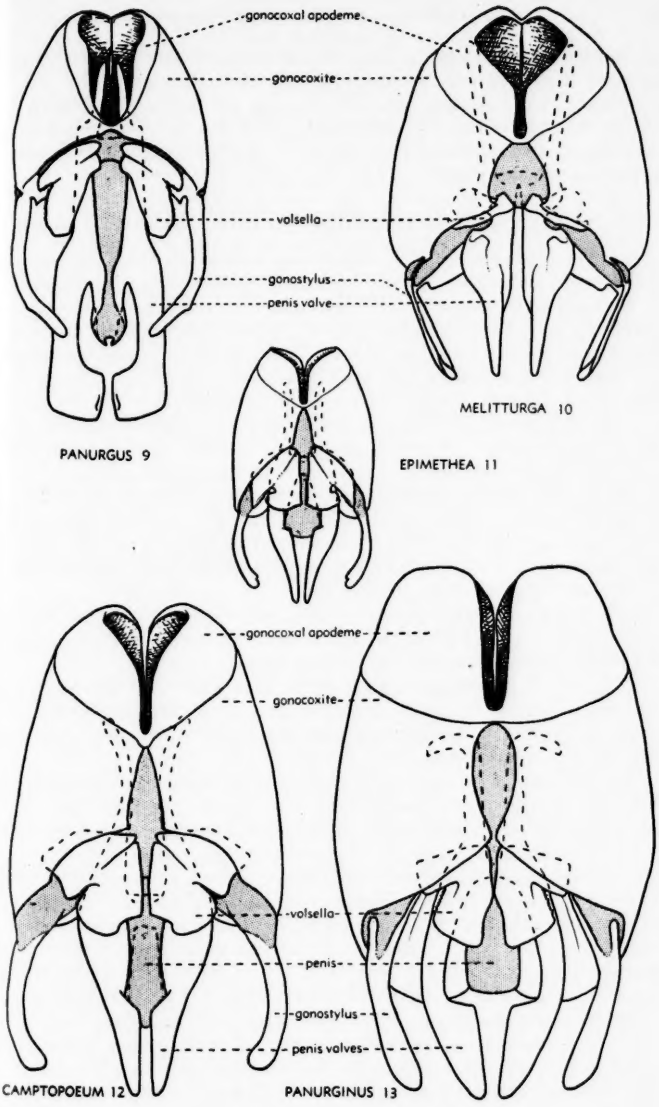


Plate III

Fig. 9. ***Panurgus banksianus*** (Kirby), ventral view of male genitalia.
Fig. 10. ***Melitturga praestans syriaca*** Friese, ventral view of male genitalia.
Fig. 11. ***Epimethea kuznetzovi*** Cockerell, ventral view of male genitalia.
Fig. 12. ***Camptopoeum rufiventre*** Morawitz, ventral view of male genitalia.
Fig. 13. ***Panurginus occidentalis*** Crawford, ventral view of male genitalia.

and digitus can not always be differentiated with certainty. Furthermore, in this group the volsellae are not always spiculated, a condition which seems to be unique for the Andrenidae. The volsellae of *Meliturgula braunsi* are fused to the gonocoxites. It is interesting to note that a similar fusion occurs in *Colletes*; however, there is no indication as to whether or not these fusions are of a homologous nature.

RELATIONSHIPS ON THE BASIS OF THE MALE GENITALIA

If the male genitalia of each of these species is analyzed as a single structure and then compared with the other male genitalia, the male genitalia of the Andrenidae are seen to fall into three major groups. These groups correspond with the subfamilies of Michener (1944a). The genitalia of the Andreninae and of the Oxaeniae each fall into a separate group even though they both have a gonobase and fused penis and penis valves. The genitalia of the Andreninae do not seem to have distinct gonostyli, while in *Protoxea gloriosa* the gonostyli are distinct, being only partly fused with the gonocoxites. Furthermore, the genital capsule of *Protoxea gloriosa* tapers anteriorly, while in the Andreninae there is no pronounced tapering.

The genitalia of the Panurginae represent the third group on the basis of having no gonobase. However, these genitalia are quite heterogeneous, so that it is possible to break the Panurginae into several subgroups. It is significant that the genera in each subgroup have approximately the same geographical distribution, as will be pointed out below.

Psaenythea and *Pseudopanurgus*, both New World genera, constitute one subgroup, since in both genera the penis valves are fused to the penis and the gonocoxal apodeme has a tendency to be inflexed.[2]

The African *Meliturgula* seems to belong to a group of its own because the penis is fused to the penis valves and the volsellae are fused to the gonocoxites, a condition that is apparently found no where else in the Andrenidae, although it is found in some colletid genera.

The genitalia of *Epimethea, Melitturga, Camptopoeum, Panurginus,* and *Panurgus*, all Old World genera except *Panurginus*, which is Holartic, fall into one group on the basis of the following characteristics: the penis is separated from the penis valves, the gonostyli are long and slender, the cuspus and digitus are distinguishable, and there is a deep, antero-ventral median indentation on the underside of the gonocoxal apodeme. This subgroup is very homogeneous with the exception of *Melitturga*, which perhaps may not belong here. Although *Melitturga p. syriaca* has the subgroup characteristics mentioned above, the digitus and cuspus are on a vertical plane instead of a horizontal plane as in all the others, and the penis of this species is very small.

Nomadopsis, Calliopsis, Hypomacrotera, and *Acamptopoeum,* New World genera, compose another subgroup on the following grounds: the gonostyli are absent (except perhaps for *A. submetallicum* and *C. coloradensis*); the penis and penis valve are not fused; and the volsellae have a tendency to fuse together and to lose their spicules. Why some species of *Nomad-*

[2] *Xenopanurgus* Michener in manuscript, a new genus, belongs to this subgroup.

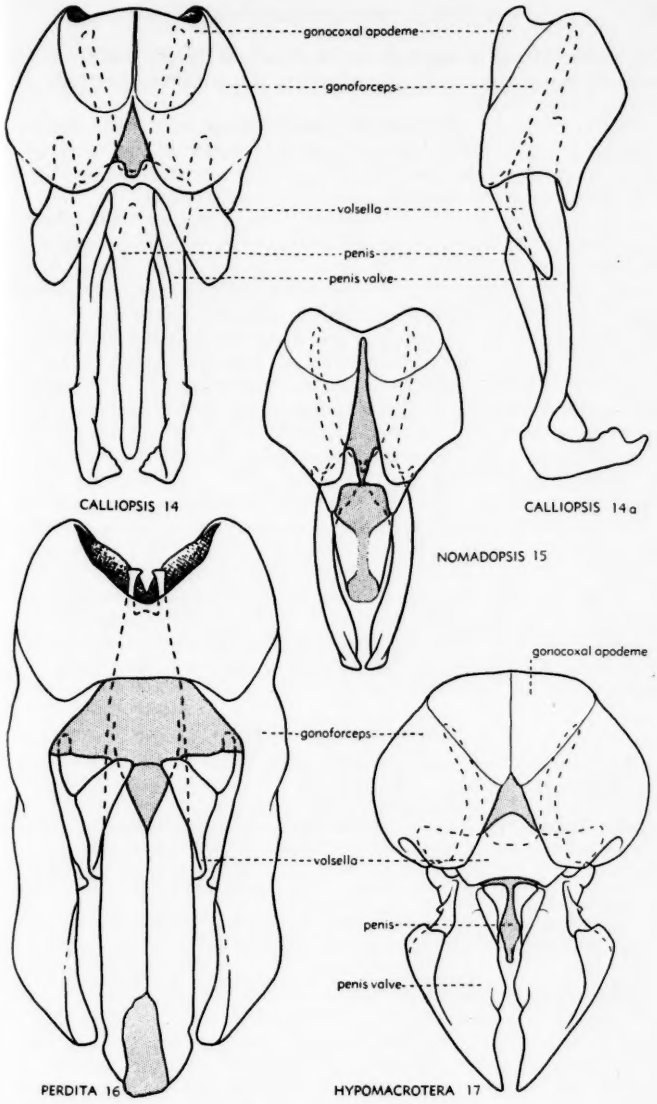


Plate IV

Fig. 14. *Calliopsis coloradensis* Cresson, ventral view of male genitalia.
Fig. 14a. *Calliopsis coloradensis* Cresson, lateral view of male genitalia.
Fig. 15. *Nomadopsis zebrata* (Cresson), ventral view of male genitalia.
Fig. 16. *Perdita (Cockerellia)* sp., ventral view of male genitalia.
Fig. 17. *Hypomacrotera subalpina* (Cockerell), ventral view of male genitalia.

opsis, Calliopsis and *Acamptopoeum* have one type of genitalia, while other species of the same genera have another type is a perplexing question which deserves further study.

Perdita seems to stand alone. The gonocoxal apodeme is like that in the *Calliopsis* group in being large and with no anterior median notch on the underside. However, the gonostyli are large and sometimes completely fused to the gonocoxites; and the penis and penis valves are fused.

Since various authors (e.g., Michener, 1944a; Lanham, 1949) believe the colletid bees to be ancestral to the andrenids, a brief study of the colletid genitalia was undertaken to try to determine the ancestral type of male andrenid genitalia. For this study *Colletes latitarsus* Robertson, *Stenotritus pubescens* (Smith) (fig. 2), *Paracolletes tuberculatus* Cockerell, and *Caupolicana yarrowi* (Cresson) were examined. It was decided that of the three andrenid subfamilies, the genitalia of the Andreninae is the most similar to the colletid type. However, this similarity is not strong as is indicated, for example, by the colletids, unlike the Andreninae, having the penis separated from the penis valves. The genitalia of *Megandrena* is thought by Lanham (1949:192) to be colletid-like, but this seems questionable in view of *Megandrena enceliae* having fused penis and penis valves and of its having extremely elongated and modified volsellae. *Stenotritus pubescens*, which is thought by Michener (1944a:238) to be perhaps intermediate between Andrenidae and Colletidae on external characteristics, has the gonocoxites broader than the base of the gonostyli, a condition which is found in *Andrena*, as Lanham (*op. cit.*) points out. However, aside from this one point the general appearance of the genitalia of the two genera is quite different. It might be said in summary that, although the genitalia of the Andreninae may be derived from the Colletidae, little evidence could be brought forward to support such a theory in this study.

ACKNOWLEDGMENT

The author wishes to extend deep thanks to Dr. C. D. Michener for his kind help in the preparation of this paper.

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A WASHING METHOD OF ECTOPARASITE RECOVERY WITH PARTICULAR REFERENCE TO CHIGGERS[1]

(Acarina-Trombiculidae)

LOUIS J. LIPOVSKY[2]

I. Introduction

Among the many problems encountered in studies of ectoparasites, the location and removal of minute, delicate parasitic forms from their vertebrate hosts are two of the more difficult and time consuming ones. The purpose of this paper is to describe a method of washing ectoparasites from their hosts by using solutions of the surface active agents Aerosol O. T. and Vatsol O. T. This method involves refrigeration of the host for a minimum of one day, followed by reasonable thawing or warming and finally the washing of the ectoparasites from the host. It is especially useful in removing chiggers. Approximately 2000 vertebrate hosts have been washed and examined with good results for both birds and mammals. The procedures are especially useful in that the majority of the mites recovered can be kept alive in solution for several weeks under refrigerated conditions (0° to 4° C), and at room temperatures (27° C or less), for several days. This is advantageous from the standpoint of biological investigations, for chiggers can be transferred and handled and even placed on other host animals with a medicine dropper. Species of chiggers recovered during the late fall, winter and early spring months are more adaptive to low temperature treatment than are species found in the summer months. After refrigeration, summer chiggers require considerably higher temperatures for activation and subsequent detachment from the hosts. Summer chiggers do not survive in solution for a long period of time as do the winter chiggers.

II. Development of the Washing Method

During the course of chigger investigations, it became apparent that chigger recovery from vertebrate hosts presented several problems—the element of time involved in the examination of the hosts, the constant danger of damaging the chiggers by forceful removal, and the variability of results when different individuals examined the host. There was no standard of chigger recovery. With these ideas in mind, washing hosts in the detergent Aerosol O.T. was tried early in March in 1947 with promising results. There was no noticeable difference in the effectiveness of Aerosol O.T. and Vatsol O.T. when the latter was tried.

Washing chigger hosts in solutions of these surface-active agents was not sufficient in itself to produce uniformly satisfactory results. It was evident that other factors were involved. Washing chiggers from their hosts gave better results during the winter months when snap-trapped animals were either frozen or chilled before they were washed. The chilling of the animals

[1] The studies upon which this paper is based were conducted under a contract, N6 ori-220 Task Order II, between the University of Kansas and the Office of Naval Research.

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was a major factor influencing the detachment of chiggers and thus their recovery by washing.

Besides chiggers, large numbers of other ectoparasites were washed off. Frequently thousands of analgesid mites were recovered from birds. Sarcoptoid mites and Mallophaga, representing all developmental stages, were also recovered in the washes. A variety of free-living forms such as copepods, tardigrades, soil and plant mites, maggots and other non-parasitic insects as well as internal parasites and their fragments were found.

The relative effectiveness of washing hosts for ectoparasite recovery, from most efficient to least, is as follows:

1. Feather and fur mites.
2. Chiggers, sarcoptoid mites (birds), and ticks.
3. Cheyletidae (recovery variable) and sucking lice.
4. Fleas and biting lice.

The reason for the inefficiency of recovery for the biting and sucking lice and the fleas is that they die in the solution. The Mallophaga, in dying, clamp onto the fur or feathers with their mandibles, and the Anoplura with their grasping legs, while the Siphonaptera become more or less entangled because of their numerous spines. If these insects are not wanted alive, they may still be collected to advantage because those that are not washed off can be located more readily when the fur or feathers are wet.

III. Preparation of Stock Solutions of Aerosol O.T. (dry) or Vatsol O.T. (paste)

The preparation of a saturated or very nearly saturated stock solution is necessary if these detergents are to be used for washing purposes. Approximately 14 grams of Aerosol O.T. will dissolve in a liter of distilled water at 30° C. When one is called upon to use tap water, 14 grams may make the solution cloudy and a flocculent precipitate will form upon settling. This is due probably to the mineral content of the tap water. The use of tap water however does not appreciably diminish the efficiency of the wash.

Both aerosol and vatsol require a minimum of 18 hours to dissolve. During this time they should be agitated occasionally. The dissolution can be accelerated by heating the water and adding the wetting agent to it in fine fragments. For convenience, two bottles can be used for stock solutions, alternating to allow time for dissolving the detergent.

IV. Preparation of the Animal for Washing

Small animals that are trapped or shot should be placed in individual, transparent cellophane bags which are then sealed by folding or stapling. Larger animals should be placed in plastic all-purpose refrigerator bags. Since these bags retain moisture, the animals in them may be kept refrigerated at 0° to 4° C for two weeks or more without affecting the majority of the parasites on them. If the hosts can not be processed within ten days, the smaller animals in cellophane bags should be sealed in jars or cans. Under these conditions chiggers have been kept alive for more than a month. Some partially engorged chiggers, washed from the hosts, have been kept alive for nine months in sealed containers at 0° to 4° C. Animals the size of rabbits and

squirrels or larger should be skinned as soon as possible with the skull intact and only the skin and skull refrigerated.

Before washing, the frozen or cold animals should be warmed to room temperature. This can be done with the animal either in or out of solution. A minimum of one hour should be allowed for the warming of a small animal and longer in the case of a larger one in order to recover the maximum number of chiggers. If the skin of the animal need not be saved, longer periods of warming produce the best results. If the skins are to be "put up" the animal should be eviscerated a few hours after snap-trapping to reduce the danger of the slipping of the fur. This is especially recommended in field work where ice is the only available method of cooling.

In the laboratory, while the animals are being washed, the cellophane bags should be examined under a microscope for detached ectoparasites. If a good quality refrigerator bag is used for larger animals, it may be rinsed with washing solution and the solution examined for ectoparasites.

V. Washing the Animals

A washing solution of more than five percent tends to reduce efficiency of ectoparasite recovery. Two to five parts of the stock solution are added to ninety-eight to ninety-five parts of water to form a solution containing not less than two nor over five percent of the detergent for the initial wash. After the initial wash the animal should be rinsed twice in water. The last rinse should not contain less than 0.1 percent detergent.

The animal to be washed is placed in a jar with a good lid and dilute detergent added to cover the animal completely. In the case of birds the tail need not be covered with the solution. For maximum efficiency the jar with the animal should not be more than two-thirds nor less than one-half full. This will, of course, depend upon the size of the animal and the size of the jar used. Thus, if a mouse is to be washed in a quart jar these proportions need not apply. The animals should not occupy more than half the space in a jar.

With the animal in the solution, the jar lid is tightened and the jar shaken, off and on, for about thirty minutes. It is essential that the animal be warm before washing if saisfactory chigger recovery is to be expected. If twelve or more animals are washed at one time, there will be no period of waiting between the steps of the procedure. Animals of larger size, stated previously, should be skinned and the skins washed. In addition it may often be advisable to section the skin and use several small jars. The smaller pieces may be examined more thoroughly under the microscope than the whole skin. When the animal is moist it is much easier to examine the fur for ectoparasites than when it is dry. All such examinations should be made under the binocular microscope to check the effectiveness of the wash.

After thirty minutes or more of washing, the animal is removed and the excess solution squeezed back into the jar. The wash water is then poured into a tall glass cylinder. The cylinders may be of several sizes to accommodate the different amounts of liquid that will result from the washes of the different sized animals. The sizes most often used are: 7″x1½″; 14″x2″; and 16½″x2½″. The wash solution in the cylinder is then permitted to settle. There will be some surface suds or "foam" from this, which must be broken

up by adding a small amount of 95% alcohol with a medicine dropper around the sides of the cylinder. The radical changes in the surface tension will disperse the foam which frequently contains trapped ectoparasites. After adding alcohol, the cylinder is rotated gently to lower the concentration of the alcohol layer at the surface.

The animal is returned to the jar in which it received its first wash and then covered with water, preferably distilled water. As in the wash, the animal is shaken vigorously. This rinsing water is then handled the same as the washing solution. If the cylinder is large enough, the rinse water may be added to the wash water already in the cylinder. This is then followed by a second rinse which may be added to the cylinder containing the wash and the first rinse water. The solution in the cylinder should then be thoroughly mixed to insure a uniform concentration of the resultant mixture. If the washes and rinses are to be included in one cylinder, the addition of alcohol to eliminate foam should take place after the last rinse is in the cylinder. If a separate cylinder is needed for the last rinse, a small amount of detergent must be added and the solution thoroughly mixed to eliminate the possibility of floating ectoparasites. These solutions should stand for at least fifteen minutes. Usually this allows most of the ectoparasites to settle to the bottom and yet does not permit time for the minute particles of dirt to settle. Air bubbles in the solution and on the specimens occasionally interfere with uniform settling in the solution. If this is noticeable, more than fifteen minutes should be allowed for settling.

When the solutions have settled sufficiently, the supernatant liquid is decanted slowly, and the residual, occasionally very dirty, is poured into a watch glass or petri dish and examined for parasites. There should not be more than 40 cc per large cylinder nor less than 10 cc for a small cylinder of the residual liquid. If too much of the supernatant liquid is poured off, some of the parasites may be lost. The liquid containing the parasites is now ready for examination under the microscope.

Magnifications up to twenty times should be used to locate the very small organisms. When the solution is dirty it hinders visual examination. It may be cleared by drawing off and discarding the excess liquid and then adding clean water and, or, diluted aerosol. This should be done under the dissecting microscope. With the addition of the clean liquid the residue will be stirred up and suspended in the solution. The heavier particles will sink to the bottom immediately, the ectoparasites will sink a few seconds later, and the fine dirt particles will remain in suspension longer. This supernatant liquid may be drawn off again with a syringe and dilute aerosol added. The end result should be a comparatively clear liquid containing the ectoparasites on the bottom. If the dirty solutions are permitted to settle for several hours in the cylinders, the finest of particles will settle leaving a mass of dirty sludge on the bottom. Under proper conditions the smallest mites should settle to the bottom of a cylinder sixteen inches high in twenty minutes. The washes of skins of animals will generally be highly colored with blood and will contain many particles of tissue and some hair.

VI. A Study of Chigger Recovery from Thirteen Rabbits

On December 4, 1948, thirteen rabbits were collected from a limited area near Lawrence, Kansas. These rabbits were skinned and the hides were washed December 6, 7, and 9. Chiggers were attached mainly on the head, with the majority of these in the ears. The four refrigerator bags which contained the thirteen rabbits yielded a total of thirteen chiggers. Most of the species were of the Genus *Trombicula*; one of the Genus *Euschöngastia*.

Four rabbits were washed on December 6. The warming time given before washing was thirty minutes. The time required to check washes and rinses, give visual examination of the skins, catalogue and count the chiggers, was five and one-half hours. The washes and rinses yielded 406 chiggers, and the examination of the skin, after the washes, 420 chiggers, mostly in the ears. In the floating hairs of the washes and rinses, six chiggers were found. The total number of chiggers was 845; mean per rabbit, 211. Of the 420 chiggers removed by hand, 296 were alive and 124 were dead.

Seven rabbit hides were washed on December 7. The total recovered in the washes and rinses was 818 after a warming time of one hour. These hides were washed a second time five hours later, having remained at a temperature of approximately 24° C, and an additional 285 chiggers were recovered. After the second wash, hand removal under the dissecting miscroscope yielded 303 chiggers, of which 189 were alive and 114 were dead. Most of these were hopelessly trapped in the ear wax. From the floating hairs of the washes and rinses, 87 chiggers were recovered. The total number of chiggers recovered was 1512, the mean per rabbit, 213. In this series of washes there was more free hair than there would ordinarily be since the hides were cut with scissors and washed in two one-quart mason jars. It has been the general practice to tear hides into sections rather than cut them for this reason.

The last two rabbits were washed on December 9. After a three hour warming period, washes and rinses yielded 344 chiggers and floating hairs gave 19. Visual examination of the hides after washing yielded 190 of which 60 were alive and 130 dead. These were mostly imbedded in wax and hence difficult to count. Total number of chiggers recovered was 553, mean per rabbit, 277.

Frequently, there is enough wax in rabbits' ears to cover chiggers completely. The chiggers which are trapped or covered with wax are, as a rule, killed. In fact, none of the chiggers which have been found completely covered with wax were ever found alive; chiggers only partially imbedded frequently are.

A study of the chigger *sinking time* in a column of solution fifteen inches high produced the following results: Engorged chigger from top of column, one minute and forty-five seconds; partially engorged chigger with small air bubble, four minutes and ten seconds; chiggers with several air bubbles often ascended. Chiggers which are carried to the surface by bubbles of air generally lose them quickly and sink. However, if there is a considerable amount of floating hair in the solution, the likelihood of the air releasing the chigger within the twenty minute period is slight.

VII. Composition and Physical Properties of Aerosol O.T. and Vatsol O. T.

The American Cyanimid and Chemical Corporation produces five products which it calls "Aerosol" and three which it calls "Vatsol". Aerosol is listed as a wetting agent—dioctyl ester of sodium sulfosuccinic acid. Vatsol O.T. is a wetting and scouring agent—dioctyl ester of sodium sulfosuccinate. The property of "scouring" which is attributed to Vatsol O.T. is not clear to the writer, especially when no appreciable difference has been noted in the two products in ectoparasite recovery.

The "Aerosols" belong to the anionic group of surface-active agents. Aerosol O.T. has the following properties: Number of C atoms in non-polar group, 16; molecular weight, 444; approximate solubility in water 14 grams per liter at 30°C. The properties of Vatsol O.T. are assumed to be very similar. One important property of a good detergent is that it lowers the interfacial tension between the solution and the solid particles, lifting these particles from the substrate so that they float off into the solution. Surface-active agents are, for the most part, compounds which contain both hydrophobic and hydrophilic groups. Both groups are important to the wetting ability of the agent. Aerosol O.T. and Vatsol O.T. are very stable compounds in their surface effects, with constant properties in solution over long periods of time. Further information can be found in Young and Coons, Surface Active Agents, Chemical Publishing Co., Inc., Brooklyn, N. Y. 1945; and in Binkerman, Surface Chemistry for Industrial Research, Academic Press, Inc. 1947.

For practical purposes in ectoparasite recovery, the wettability of a given solution of Aerosol O.T. or Vatsol O.T. is correlated with the amount of suds produced by shaking, and thus its approximate dilution. Some idea of the wetting properties of a solution can be obtained by placing a drop on a piece of paper and contrasting its rate of spread with that of a drop of water.

Ectoparasites, with the exception of those previously mentioned, will stay alive for days in any moderate concentration of aerosol or vatsol, with no apparent detrimental effect, providing temperatures are not above the optimum. At lower temperatures most ectoparasites will remain relatively inactive and alive for weeks. Some chiggers can be frozen in aerosol solution and kept alive for months. The full extent of these possibilities has not been investigated. Other advantages of handling chiggers and many other ectoparasites with a wetting agent are: The simplification of confinement, handling and storage; counting; and infestation of hosts.

Note: Since the preparation of this paper, the detergent "Glim" has been used with success. It is manufactured by B. T. Babbitt, Inc., New York, N. Y. This product can be obtained generally where household detergents are sold. The fact that it is a liquid (yellow) eliminates the preparation of stock solutions. A few drops of this material in water is sufficient to wash a small mammal or bird. No effort was made to obtain information on its physical properties; however, it compares favorably with Aerosol O.T. and Vatsol O.T. in ectoparasite recovery and other biological investigations. Extensive experiments were not conducted as to the length of time chiggers will remain alive in solutions containing Glim.

RECORDS AND DESCRIPTIONS OF NEARCTIC CADDIS FLIES

Part III

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The new species described in this paper are from Arizona, California and Oregon. Two of the new species described herein, *Ecclisomyia bilera* and *Tinodes siskiyou* are in genera with but five and six described species from the United States and Canada and are all restricted to the western montane region. Unless otherwise designated types of the new species are in the author's collection at the University of Wyoming.

Agapetus arcita n. sp.

This species is related to *malleatus* Banks and *marlo* Milne. It can easily be distinguished from those species by the acuminate dorsad directed clasper and by the shape of the tenth tergite. It represents the twenty-second species to be described from the nearctic region.

Male: Length 4.5 mm. General coloration of wings, head and thorax fuscous, legs and antennae a trifle lighter in color. Lateral bulbous organ occupying most of fifth sternite; mesal projection of sixth sternite short, blunt.

Genitalia as in Fig. 1. Ninth segment annular, considerably widened ventrally to about two and one half times that of dorsal portion. Lateral plates of tenth tergite heavily sclerotized, directed slightly ventrad, apex sub-acute from lateral or dorsal aspect, near apex appear a pair of flattened black spinules; from dorsal aspect basal margins confluent, lateral plates slightly divergent, apices turned slightly laterad. Cerci digitate, relatively prominent, arise from ventral margin of tenth tergite and bear a scattering of long setae along dorsal margin. Claspers directed dorso-caudad, gradually narrowed distally to an acute apex; from ventral aspect, Fig. 1B, bases fused on meson, apical portion slightly convergent. Aeadeagus lightly sclerotized, long extending from tenth tergite to sixth sternite.

Female: Length 5 mm. Similar in color, size and general structure to male. Fifth sternite bearing a crescentric slightly elevated line extending most of length of sternite. Sixth sternite bearing the usual mesal process, essentially similar in appearance to male. Eighth segment, lateral aspect, as in Fig 1C. Tergum of eighth segment heavily sclerotized, projecting caudad as a thick plate; from dorsal aspect broadly rounded. Sternum of eighth segment with entire caudad margin sub-membranous, remainder heavily sclerotized; caudo-ventral portion rounded, projecting caudad beyond remainder, setation fairly dense; a pair of apodemes extend from lateral heavily sclerotized portion to seventh sternite. Ninth segment tubular, lightly sclerotized; a pair of long slender internal sinuate apodemes extend from dorsal portion of ninth segment to seventh sternite. Tenth tergite lightly sclerotized, consists of a small semi-circular plate, bearing a pair of long lightly sclerotized two-segment style-like processes, combined length one and one-half times length of tenth tergite, apex bearing several spicules.

Holotype. Male. Herkey Creek, San Jacinto Mts., California, June 14, 1940, (C. D. Michener).

Allotype. Female. Same data as for paratype.

Holotype and allotype deposited in the collections of the University of California, Berkeley, California.

Wormaldia hamata n. sp.

On the basis of the elongated tergum of the eighth segment this species may easily be distinguished from other described species. *Wormaldia hamata* is a member of the *Moesta* group, of the species in that group it bears most resemblance to *strota* (Ross), and is the thirteenth species in the genus to be described from the nearctic region.

Male: Length 4.5 mm. General color of head, thorax and wings fulvous, legs and spurs flavescent. Fore and hind wings with R_{2+3} branched, M_{3+4} unbranched. Seventh abdominal sternite with apical margin produced caudad about one half distance of eighth sternite as a broad triangular process.

Genitalia as in Fig. 2. Eighth sternite produced caudad as a short triangular process; eighth tergum greatly extended, produced dorso-caudad to a distance beyond ninth segment; seen from dorsal aspect, Fig. 2B apical margin with a shallow emargination, setation sparse. Ninth segment annular, ventral margin produced caudad beyond dorsum. Tenth tergite tapering gradually caudad from a wide base to a sub-acute apex, Fig. 2A, devoid of setae. Cerci digitate, projecting dorsad of tenth tergite, shorter than tenth tergite, setation relatively sparse. Basal segment of clasper slightly shorter than apical, dorsal margin arcuate; apical segment with dorsal and ventral margins nearly parallel, apex circular, bearing a pad of dense reddish spicules on mesal surface; from ventral aspect, apical segments only slightly divergent.

Holotype. Male. Hayden Flats, California, Trinity River, July 30, 1950, 1200 feet altitude, (C. P. Alexander).

Tinodes siskiyou n. sp.

Male: Length 4.5-5.5 mm. Wings uniformly brownish. Palpi brownish, all segments mottled with small silvery dots. Antennae light fuscous. Legs, spurs uniformly fuscous, no preapical spine on front tibia.

Genitalia as in Fig. 3. Ninth tergite triangular, apex acute, directod dorso-caudad; apex and lateral margin fringed with membranous lobe. Cerci elongate, fusiform, projected caudad beyond any other portion of genitalia. Basal segment of clasper somewhat rectangular, dorsal margin arcuate, ventral margin concave; apical segment slightly shorter than basal, considerably narrowed, distal margin deeply emarginate, produced into a dorsal caudad directed spur and a ventral sub-quadrate process with the dorsal margin produced into a spur; seen from ventral aspect basal portion fused on meson, apical segments gradually convergent. Mesal blade, arising from mesal surface of basal segment of clasper wide, dorsal margin rounded, extending caudad to apical margin of basal segment, cephalad to this process there is a pair of dorsad directed, heavily sclerotized apically acute processes. Aedeagus long, slender, apex sub-acute, along dorsal margin arises a membranous fold bearing a heavily sclerotized pair of hooked processes, best discernable from dor-

sal view, Fig. 3B; sheaths gradually widened distally, bearing a dorsal cluster of spines approximately midway, a cluster near apex and a third cluster along the apico-ventral margin.

Holotype. Male. Rouge River National Forest, Beaver Sulphur Camp, Jackson Co., Oregon. Altitude 1750 feet, August 10, 1950, (C. P. Alexander).

Paratypes. 2 males, same data as for holotype; 3 males, same data but collected by K. M. Fender.

Dr. C. P. Alexander states that the specimens were taken at night using a Coleman lantern, and were collected along Beaver Creek, a small stream near the Siskiyou National Forest.

This species is related to *parvula* Denning and *signodana* Ross, but on the basis of the shape of the apical segment of the clasper and the mesal blade of the clasper, the hooked dorsal processes of the aedeagus and the distally widened sheaths of the aedeagus it can easily be separated. *Tinodes siskiyou* is the sixth species described in the genus from the nearctic.

Oecetis arizonica n. sp.

General appearance of this species is similar to *Oecetis disjuncta* Banks, but on the basis of the remarkably different genitalia it can readily be distinguished from it and other described species. Apparently *Oecetis arizonica* is well distributed in central and southern Arizona.

Male: Length 9-10 mm. Wings uniformly brownish; forewings with eight scattered dark brown spots in the membrane; hind wings without any trace of maculation.

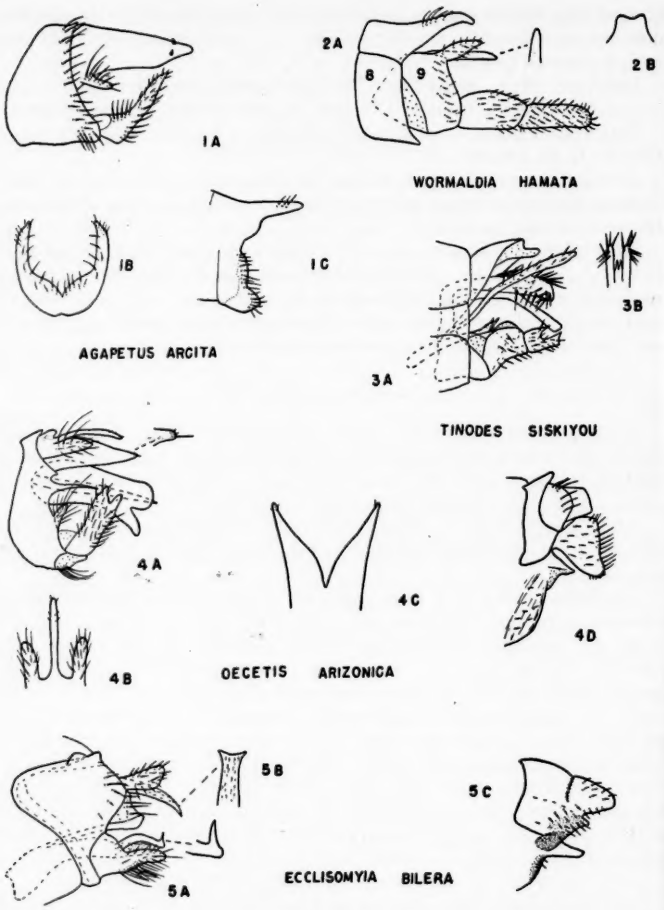
Genitalia as in Fig. 4. Ninth segment annular, dorsal portion reduced; dorsolateral margin produced into a relatively long acuminate spine lying along side aedeagus; ventro-lateral portion produced dorso-laterad as a digitate lobe bearing long stout setae. Tenth tergite somewhat roof-like, semimembranous, ventral margin most heavily sclerotized, cleft nearly to base, each lateral plate projected slightly laterad especially when viewed from dorsal aspect, Fig. 4C, apex sub-acute, bearing a small seta and a pair of spicules. Cerci elongate, about same width throughout, between cerci arise a long slender apically sub-acute style, easily discernible from dorsal aspect, Fig. 4B. Clasper elongate, about same width throughout, distal margin divided into two sub-apical lobes, entire clasper clothed with medium to long setae. Aedeagus large, base bulbous, apex with a ventral trough-like projection; internally a long acuminate dark brown rod, reaching entire length of structure.

Female: Length 10-11 mm. General structure and coloration of fore wing essentially identical to that of male. Genitalia as in Fig. 4D.

Holotype. Male Huachuca, Gordon Canyon, Cochise Co., Arizona, June 23, 1950, (C. P. Alexander).

Allotype. Female. Granite Dells, Yavapai Co., Arizona, July 3, 1950, (R. H. Beamer).

Paratypes. 7 ♂ ♂, 8 ♀ ♀, same date as allotype; 1 ♂ same data as for holotype; 1 ♂, Mt. Lemon, Pima Co., Arizona, July 14, 1950, (R. H. Beamer); 2 ♂ Chiricahua Mts., Rustler Park, Cochise Co., Arizona, 8-9000 feet altitude, July 3, 1927, (J. A. Kusche).



EXPLANATION OF PLATE

Fig. 1 *Agapetus arcita*; 1A, male genitalia, lateral aspect; 1B, claspers, ventral aspect; 1C, female genitalia, lateral aspect, eighth segment.

Fig. 2. *Wormaldia hamata*; 2A, male genitalia, lateral aspect; 2B, eighth tergite, dorsal aspect.

Fig. 3 *Tinodes siskiyou*; 3A, male genitalia, lateral aspect; 3B, dorsal processes of aedeagus and sheaths, dorsal aspect.

Fig. 4 *Oecetis arizonica*; 4A, male genitalia, lateral aspect; 4B, style and cerci, dorsal aspect; 4C, tenth tergite, dorsal aspect; 4D, female, genitalia, lateral aspect.

Fig. 5 *Ecclisomyia bilera*; 5A, male genitalia, lateral aspect; 5B, tenth tergite, dorsal aspect; 5C, female genitalia, lateral aspect.

Allotype and 8 paratypes deposited in the Collections of the University of Kansas; 2 ♂ paratypes in the collections of the California Academy of Sciences and 1 ♂ paratype in the collection of the University of Massachusetts.

Ecclisomyia bilera n. sp.

This, the fifth species described in the genus, is closest related to *scylla* Milne. The ventrad directed tenth tergite, the elongate claspers, the hooked sinuate processes of the aedeagus and the peculiar thin flattened process arising from the base of the aedeagus will readily distinguish it from that and other described species.

Male: Length 9-11 mm. Wings brownish, forewings with mottling of light yellowish spots in membrane which are well scattered over entire wing. Head, thorax and femora dark fuscous, tibia, tarsus and spurs yellowish, antennae about same color as wings.

Genitalia as in Fig. 5. Ninth segment with dorsal portion greatly expanded, margin heavily sclerotized, remainder very light. Cerci gradually widened distally, margins almost parallel-sided; from dorsal aspect divergent, apices rounded. Tenth tergite directed ventrad, approximately same width throughout, distal margin with a wide triangular incision, Fig. 5B, dorsal surface with a scattering of spicules. Claspers elongate, gradually narrowed distally, apex varies from sub-acute to truncate; claspers devoid of any mesal spines, yellowish setae fairly abundant along ventral margin. Articulated to base of aedeagus there is a thin, flat, immovable plate-like process, extending caudad beyond ninth segment where it joins a membranous lobe, distal portion widely cleft, divergent. From distal portion of aedeagus arise a pair of sinuate lateral apically hooked processes, heavily sclerotized, extending caudad beyond ventral membranous tubular portion.

Female. Length 10-11 mm. Essentially similar to male in coloration and general structure. Genitalia, Fig. 5C, relatively simple, tenth tergite deeply cleft.

Holotype. Male. Lassen Volcanic National Park, California, Kings Creek Meadows, altitude 7400 feet, July 23, 1950, (C. P. Alexander).

Allotype. Female. Same data as for holotype.

Paratypes. 18 ♂ ♂ 3 ♀ ♀, same date as for holotype, 2 ♂ ♂, same data but August 17, 1950. 4 ♂ paratypes deposited in the collections of the University of Massachusetts and the Illinois Natural History Survey.

Ecclisomyia maculosa Banks

Ross (1950) has recorded this species from Alberta, British Columbia, Colorado, Montana and Wyoming. New distributional records are available as follows: Oregon: Crater Lake, Pole Creek Meadows, 5950 feet; Aug. 7, 1948, C. P. Alexander; Mt. Hood, Iron Creek, July 31, 1948, C. P. Alexander. It is probably the most abundant species of the genus in Wyoming and is usually taken at about 10,000 feet altitudes in July and August.

Ecclisomyia simulata Banks

Ross has recorded this species from Nevada, Oregon and Washington. New distributional data are as follows: Lassen, California, Kings Creek

Meadows, Aug. 17, 1950, 7400 feet, C. P. Alexander; Plumas Co., California, Meadow Valley, June 1, 1924, E. C. Van Dyke.

Ecclisomyia conspersa Banks

Recently the writer was sent several dozen pupae from Karluk Lake, Alaska, collected by Wm. M. Morton from the stomachs of Dolly Varden trout. In addition to Alaska the species is quite commonly taken in Montana, Oregon, Alberta and Washington. In addition to these Ross (1950) has also recorded the species from California and British Columbia. This species appears to have the widest range of any of the described *Ecclisomyia.*

Ecclisomyia scylla Milne

Very few records of this species are available. Ross has recorded it from British Columbia, Washington and Oregon. Four males are available from Mt. Baker, Washington, 4000 feet altitude, Aug. 10-12, 1947, C. P. Alexander.

REFERENCES

Ross, H. H., 1950. Synoptic Notes on Some Nearctic Limnephilid Caddisflies (Trichoptera, Limnephilidae). Amer. Midland Naturalist. 43, (2): 410-427, 22 figs.

WESTERN RECORDS OF THE MAYFLY GENUS STENONEMA

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Berner (The mayflies of Florida:57; 1950) in his discussion of *Stenonema* remarks that "No species are known from western North America, . . .", and Spieth's statement (Ann. Ent. Soc. Amer., 40:87;1947) that the "genus *Stenonema* is abundant and ecologically widely distributed in North America east of the Rocky Mountains" may convey the same impression to some readers. It therefore seems desirable to call attention to a published record of *Stenonema terminatum* Walsh in the West and also report some new records. Traver (Biology of Mayflies :332; 1935) has recorded this species from Lewiston, Idaho, and the writer has additional series from Nampa, (Aug. 23, 1947) and New Plymouth, Idaho (Aug. 20, 1947). *Stenonema terminatum* adults were collected recently at Saratoga resort on the west side of Utah Lake, Utah (June 11, June 29, July 31, 1950). Extensive search of the standing water of a canal and the few rocks on the wave-washed shores of the lake yielded no nymphs. A month later a single nymph of this species was collected on *Potamogeton filiformis* in a canal at Kearns, Salt Lake Co., Utah. According to Spieth (in letter), McDunnough has numerous specimens from British Columbia which he has placed as *S. terminatum* Walsh.

Thus it would seem that although at the present time only one species of *Stenonema* is known from west of the Continental Divide, this species is relatively widespread.

UTAH HELEIDAE

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Heleidae were collected whenever opportunity arose during 1950. This was done in an effort to learn more of the occurrence of this family, in which at least two species, *Leptoconops kerteszi* Kief. and *Culicoides variipennis* (Coq.) have, at times, proved to be extremely numerous and annoying. These are the only two genera having any direct economic significance, Dr. Willis W. Wirth pointed out. The writers are indebted to Dr. Wirth for identifying the material recorded below. Nearly all of the specimens were collected in Utah during 1950.

Atrichopogon sp. Carter Creek, Uintah Mts., July 14, 1950 (Knowlton); in celery field, Corinne, September 7 and 16, 1949 (Knowlton); on celery, Magna, October 5, 1950, (Knowlton). (*A fusculus* Coq. was collected at Burnt Fork, Wyo., July 15, 1950 by Knowlton).

Bezzia spp. Parowan Canyon, June 20, 1950 (Knowlton and G. E. Bohart); Kanab, June 21, 1950, at-light (Knowlton and Bohart).

B. expolita (Coq.) St. George, June 20, 1950 (Knowlton and Bohart).

Culicoides crepuscularis Mall. St. George, June 21, 1950 (Bohart and Knowlton).

C. hieroglyphicus Mall. Kanab, June 21, 1950 (Bohart and Knowlton); St. George, June 20, 1950 (Knowlton and Bohart).

C. stellifer (Coq.). Kanab, June 21, 1950 (Bohart and Knowlton).

C. variipennis (Coq.). Kanab, July 21, 1950 (Bohart and Knowlton); Kaysville, July 19, 1950 (Knowlton); St. George, June 20, 1950 (Knowlton and Bohart).

Dasyhelea spp. Bridgeland, July 12, 1950 (Knowlton); Carter Creek, Uintah Mts., July 14, 1950 (Knowlton); Hideout Canyon, Dagget County, July 14, 1950 (Knowlton); at-light, Kanab, June 21, 1950 (Knowlton and Bohart); Ogden, July 19, 1950 (Knowlton); Parowan Canyon, June 20, 1950 (Knowlton and Bohart); Perry, July 19, 1950 (Knowlton); Roosevelt, July 12, 1950 (Knowlton); St. George, June 12 and 20, 1950 (Bohart and Knowlton); Washington meadows, July 21, 1950 (Knowlton and Bohart).

D. grisea (Coq.). In celery field, Corinne, August 18, 1949 (D. McComb and Knowlton); Moab, June 16, 1950 (Knowlton).

D. mutabilis (Coq.). In celery field, Corinne, September 7, 1949 (Knowlton); Moab, June 16, 1950 (Knowlton).

Forcipomyia spp. Green River near Bear Mt., July 14, 1950 (Knowlton); Ogden, July 19, 1950 (Knowlton); Roosevelt, July 12, 1950 (Knowlton); St. George, July 19, 1950 (Knowlton).

F. brevipennis (Macq.). In celery field, Honeyville, September 22, 1949 (Knowlton).

F. squamiipes (Coq.). At light, Kanab, June 21, 1950 (Knowlton and Bohart).

Leptoconops kerteszi Kief. St. George, June 20, 1950 (Knowlton and Bohart).

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